



The Role of the Ultrasonography of Abdomen Performed by a General Surgeon on Diagnosis of Acute Appendicitis

Genel Cerrahi Uzmanınca Yapılan Batın Ultrasonografisinin Akut Apandisit Tanısındaki Yeri

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ABSTRACT

Aim: In this study, we aimed to investigate whether abdominal ultrasonography (USG) performed by a general surgeon provides significant contribution to himself in diagnosing acute appendicitis.

Method: This study was performed at two different hospitals where referral of patients to another hospital is not possible due to geographical reasons. Two hundred fifteen patients with suspicious diagnosis of acute appendicitis were included into the study among 2140 patients with abdominal pain at three different periods during 12 months. Data of the patients were evaluated retrospectively and patients were divided into three groups. Group 1 and 2 include patients followed and treated in the same hospital. Group 1 patients were followed and treated by general surgeon using conventional methods without abdominal USG. Group 2 patients were followed and treated by same general surgeon using both conventional methods and abdominal USG. Group 3 patients were followed and treated by a different general surgeon in a different hospital using conventional methods and abdominal USG performed by a radiologist.

Results: Of patients, 200 male and 15 were female, and mean age was 23. A total of 66 patients from all groups underwent appendectomy. When the groups were compared with according to the pathological results which were consistent with acute appendicitis; there was not statistically significant difference among groups ($p=0.362$). Conservative treatment were applied to the patients with sonographically negative for appendicitis and with negative findings for physical examination and laboratory tests in their follow-up. When the groups were compared in terms of correctly identification of non-acute appendicitis and avoidance of negative appendectomy (laparotomy); statistically significant difference in favor of group 2 ($p=0.002$) was found.

Conclusion: According to the results of the study; when surgeons use USG as an adjunctive method, the rate of negative appendectomy decreases.

Keywords: Appendicitis, general surgeons, ultrasonography

ÖZ

Amaç: Bu çalışmada; genel cerrahi uzmanınca yapılan batın ultrasonografi (USG) tetkikinin, akut apandisit tanısında genel cerrahi uzmanına sağlayacağı katkısı ortaya koymayı amaçladık.

Yöntem: Bu çalışma, coğrafi nedenlerden dolayı başka bir merkeze sevkleri mümkün olmayan hastaların yer aldığı iki farklı merkezde gerçekleştirildi. Çalışmaya 1 yıl süresince üç farklı periyotta karın ağrısı şikayeti ile başvuran 2140 hastadan, akut apandisit şüphesi ile takibe alınan 215 hasta dahil edildi. Hastalar üç gruba ayrıldı ve veriler retrospektif olarak değerlendirildi. Birinci ve ikinci grup hastalar aynı merkezde takip ve tedavisi yapılan hastalardan oluşturuldu. Birinci grup, batın USG olmaksızın genel cerrah tarafından diğer yardımcı yöntemler kullanılarak takibi ve tedavisi yapılan hastaları içermektedir. İkinci grup, aynı cerrah tarafından diğer yardımcı yöntemlere ek olarak batın USG incelemesi yapılarak takip ve tedavisi yapılan hastaları içermektedir. Üçüncü grup ise farklı bir merkezde diğer yardımcı yöntemlere ek olarak radyoloji uzmanınca yapılan batın USG incelemesiyle başka bir genel cerrah tarafından takibi ve tedavisi yapılan hastaları içermektedir.

Bulgular: Çalışmaya dahil edilen 215 hastanın 200'ü erkek, 15'i kadın hasta olup yaş ortalaması 23 idi. Tüm gruplarda toplam 66 hastaya apandektomi ameliyatı yapıldı. Gruplar, patoloji sonucunun akut apandisit ile uyumlu olması açısından karşılaştırıldığında aralarında istatistiksel olarak anlamlı bir fark bulunmadı ($p=0,362$). Sonografik olarak akut apandisit saptanmayan, takiplerinde fizik muayene ve laboratuvar bulguları negatif seyreden hastalara konservatif tedavi uygulandı. Gruplar akut apandisit olmayanları doğru tespit etme ve negatif laparotomiden (apandektomiden) kaçınma açısından karşılaştırıldığında, gruplar arasında ikinci grup lehine istatistiksel olarak anlamlı bir farklılık saptandı ($p=0,002$).

Sonuç: Çalışma sonuçlarına göre; cerrahlar, yardımcı yöntem olarak kendileri tarafından yapılan batın USG'yi kullandıklarında, negatif apandektomi oranı daha da azalmaktadır.

Anahtar Kelimeler: Apandisit, genel cerrahlar, ultrasonografi



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Introduction

Abdominal pain is one of the most common causes of emergency department visits.¹ Along with clinical examination and biochemical tests, ultrasonography (USG) is still an important part of the diagnostic pathway for these patients. In many countries, abdominal USG is performed by specialists in radiology departments. However, this approach causes loss of precious time in the diagnosis of emergency patients. Bedside abdominal USG performed by an emergency department specialist or a general surgeon at the emergency department will contribute to quicker evaluation of the patients.^{2,3} Acute appendicitis is the most common cause of acute abdomen in general surgery patients.⁴ Diagnosis is usually made through patient history and physical examination. However, complementary techniques such as abdominal USG, leukocyte count, and direct abdominal x-rays are also used. As negative laparotomy rate is 10-30% in acute appendicitis cases, abdominal USG may contribute to surgical diagnosis, and reduce this rate.⁵ With this study, we aimed to evaluate the contribution of abdominal USG by general surgeons in the diagnosis of acute appendicitis.

Materials and Methods

This study, which was conducted in two different centers that could not transfer patients to other centers because of geographical reasons, included 215 patients with preliminary diagnosis of acute appendicitis among 2140 patients who presented with abdominal pain during three different 12-month-periods. Patients were divided into 3 groups. The first and second groups were treated and followed up at the same center while the third group was treated at a different center. The first group included patients that were treated and followed up using history, physical examination, leukocyte count, and direct abdominal x-ray by the general surgeon as there was no USG device available. The second group of patients was followed up after the purchase of an USG device at the same center by the same general surgeon, who is experienced in abdominal USG, with history, physical examination, leukocyte count, and direct abdominal x-ray along with abdominal USG. The third group included patients treated and followed up at another center by a different general surgeon for 12 months with history, leukocyte count, direct abdominal x-ray, and abdominal USG performed by a radiologist (Flow Chart 1). In the correct diagnosis of acute appendicitis, Alvarado score was used along with clinical experience (Table 1). Patients with an Alvarado score over 7 were considered to have acute appendicitis.⁶ In the abdominal USG, transverse diameter of appendix >6 mm, noncompressibility, absence of peristaltic

movements, and confirmation of appendix as a blind ending was accepted as positivity.⁷ Pathological evaluation of the pieces removed during appendectomy was made at a higher center. Patient data was evaluated retrospectively.

Statistical Analysis

Statistical Package for Social Sciences Software (SPSS version 22.0, SPSS Inc., Chicago, IL, USA) was used for the statistical analyses. Statistical comparisons were made using chi-squared test.

Results

Of the 215 patients included in the study, 200 were men and 15 were women, and mean age of the patients was 23. A total of 66 patients were appendectomized in all groups. Among 620 patients in the first group who presented at the emergency department with abdominal pain, 65 were followed up with suspected acute appendicitis. Twenty six of these patients were appendectomized. In the postoperative histopathologic evaluation, 21 patients had confirmed acute appendicitis, while 5 patients had negative appendectomy. Thirty nine patients that were treated conservatively clinically improved without the need for an operation. Their clinical and laboratory parameters returned to normal. In the second group, 100 out of 960 patients that presented with abdominal pain were followed up by the same general surgeon with suspected acute appendicitis. All 100 patients were evaluated by the general surgeon with abdominal USG. Patients with USG signs consistent with acute appendicitis went through appendectomy. Histopathologic evaluation was consistent with acute appendicitis in 18 of the patients, while one patient had negative appendectomy. Eighty one patients that were treated conservatively improved during follow-up, and their clinical and laboratory findings returned to normal, without operation. Among the 560 patients in the third group who presented with abdominal pain 50 patients were admitted by a different general

Table 1. Alvarado score

Clinical Findings	Score
Migrating abdominal pain	1
Loss of appetite	1
Nausea/Vomiting	1
Tenderness in the right iliac fossa	2
Rebound tenderness	1
Fever (>37.3 °C)	1
Leukocyte count >10.000/mm ³	2
Neutrophilia (>75%)	1
Total	10

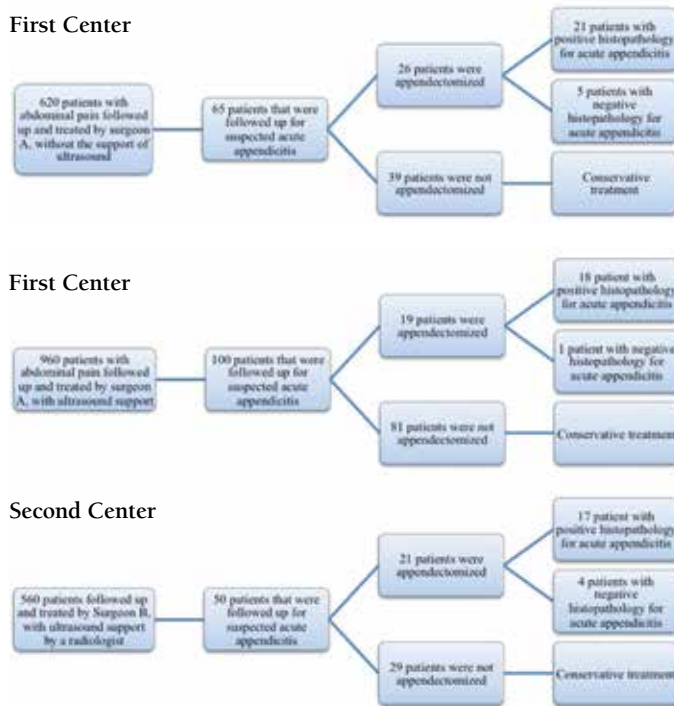
surgeon with suspected acute appendicitis. All patients that were admitted for observation were evaluated by a radiologist with abdominal USG. Twenty one patients with USG findings of appendicitis went through appendectomy. In 17 of these patients, histological evaluation confirmed the diagnosis, while appendectomy was negative in 4 patients. Twenty nine conservatively-treated patients improved with follow-up, their clinical and laboratory findings returned to normal, and they did not need an operation. Operated patients and their pathology results are presented in Table 2. When the histological confirmation rates after appendectomy were compared, there was no statistically significant difference between the groups (p=0.362). Patients who did not have findings consistent with acute appendicitis in the abdominal USG, supported by

repeated clinical examination and laboratory tests, received conservative treatment. Comparison of patients who received conservative treatment as opposed to operation, there was a statistically significant positive difference in the second group (p=0.002). Meaningly, the second group was superior to the other groups in terms of correct identification of the patients without acute appendicitis, and avoiding negative laparotomy (appendectomy). Sensitivity, specificity, positive and negative predictive values of abdominal USG used in groups 2 and 3 are presented in Table 3. Number of patients that were conservatively treated, whose follow-up and control visits established that they did not have acute appendicitis is presented on Table 4.

Discussion

While early diagnosis and treatment is associated with better outcomes in acute appendicitis, which is the most common cause of acute abdomen in general surgery patients, diagnostic delays cause increased morbidity and mortality. There is no method that is 100% successful in the diagnosis of acute appendicitis, and the most important step in the diagnosis is patient history and physical examination.

In the first group of our study, diagnosis of acute appendicitis was made with patient history and physical examination because of the absence of a radiologist and an USG device. Leukocyte count and direct abdominal x-ray were used as supplementary methods. In this group, 21 out of 26 patients had histologically confirmed acute appendicitis, while 5 patients (19.2%) did not. This result is consistent with many studies in the literature that did not involve imaging studies, where the reported negative appendectomy rates are approximately 20%. Amgwerd et al.⁸ have reported the correct diagnosis rate with only physical examination as 80%. There are many studies that demonstrate that abdominal USG may be used in the diagnosis of acute appendicitis and reduce the negative appendectomy rates.^{9,10,11,12}



Flow Chart 1.

Table 2. Appendectomized patients and their pathology results

	Patients followed up for suspected acute appendicitis, n	Appendectomized patients, n (%)	Pathology results	
			Histopathologically positive for acute appendicitis, n (%)	Histopathologically negative for acute appendicitis, n (%)
Group 1	65	26 (40%)	21 (80.8%)	5 (19.2%)
Group 2	100	19 (19%)	18 (94.7%)	1 (5.3%)
Group 3	50	21 (42%)	17 (81.0%)	4 (19.0%)
Total	215	66 (30.7%)	56 (84.8%)	10 (15.2%)
p=0.362				

USG performed by general surgery specialists may increase the correct diagnosis rate when combined with other clinical and laboratory findings. We reviewed three studies in the literature about the use of USG by surgeons in the diagnosis of acute appendicitis. Two of the studies were conducted by general surgeons, and one was conducted by pediatric surgeons. Butfort et al.¹³ compared the use of USG by pediatric surgeons vs radiologists, while Zielke et al.¹⁴ have compared USG performed by general surgeons and studies where USG was performed by radiologists. Amgwerd et al.⁸ however, compared USG imaging performed by general surgeons with very little experience in USG, vs those experienced in USG. In these studies, USG studies performed by general surgery specialists were compared to those performed by radiologists or inexperienced general surgery specialists, and results were similar or even better in some studies. In the second group of our study, abdominal USG was performed by a general surgery specialist. Along with physical examination and biochemical laboratory tests, abdominal USG was performed in 100 patients with suspected acute appendicitis. Nineteen of these patients who had USG findings consistent with appendicitis went through appendectomy. 94.7% of these patients had histopathologically confirmed acute appendicitis. The success rates in our study were found to be higher than those in published literature. We think that these higher rates are because the general surgeon is more experienced in evaluating the clinical features of patients.

Table 3. Sensitivity, specificity, accuracy, positive and negative predictive values of abdominal ultrasound

	Sensitivity	Specificity	PPD	NPD	Accuracy
Group 2	100	98	94	100	99
Group 3	100	87	80	100	92

PPD: Positive predictive value, NPD: Negative predictive value

Table 4. Number of patients that were conservatively treated, without appendectomy (patients who were concluded to not have acute appendicitis upon follow-up and control visits)

	Patients followed up with suspected acute appendicitis, n	Patients that were not appendectomized, n (%)*
Group 1	65	39 (60%)
Group 2	100	81 (81%)
Group 3	50	29 (58%)
Total	215	149 (69.3%)

p=0.002 (* None of the patients that were not appendectomized received a diagnosis of acute appendicitis upon follow-up)

In the third group of the study, 50 patients were imaged with USG by a radiologist, and 21 patients with USG findings of acute appendicitis went through appendectomy. Histopathological diagnosis was acute appendicitis in 17 (80.9%) of these patients, while it was not in 4 (19.1%) patients. These rates are consistent with the published studies. Both of the centers taking part in the study were the only surgical centers within their respective regions, and patients could not be referred to other centers. Because of this, patients did not have the possibility of having this operation in other centers. In our study, 39 patients in group 1, 81 patients in group 2, and 29 patients in group 3 were followed up conservatively without an operation. None of these patients, who were either followed up for a while and discharged, or sent home and called for a control visit, needed an operation. When the groups were compared in terms of correct identification of patients without acute appendicitis and avoiding negative laparotomy (appendectomy), group 2 showed a positive and statistically significant difference (p=0.002).

When different studies are reviewed,^{15,16,17} abdominal USGs performed by radiologists have a sensitivity of 65-90%, specificity of 90-100%, effectiveness of 89-95%, positive predictive value of 80-89%, and negative predictive value of 76-92%. In our study, however, when the three groups are compared, rate of correct diagnosis was lowest in the first group, while it was highest in the second group whose abdominal USGs were performed by a general surgeon. It is a fact that use of abdominal USG in the diagnosis of acute appendicitis reduces the rate of negative laparotomies. However, it is also important who is performing the abdominal USG. As in our study, it is possible that the accuracy rate of abdominal USGs performed by a general surgeon may be higher than those performed by a radiologist. Taking the results of our study into account, we think that USG education given to general surgeons may increase the correct diagnosis rate, and reduce the rate of negative laparotomies (appendectomies) especially in male patients without acute appendicitis. This is why we support the incorporation of "Use and interpretation of USG in the diagnosis of acute abdomen" into the General Surgery Residency Training Core Competency Program published in 2006, which has the potential to be dynamically revised by the Turkish Board of Surgery.¹⁸

Study Limitations

The low number of patients involved in the study, the fact that only 15 out of 215 patients are women with regards to differential diagnosis of acute gynecopathologies involving right lower quadrant, the fact that the surgeon in all 3 groups was not the same, and most importantly, the fact that the surgeon performing abdominal USGs did not have

a formal USG education but learnt to perform USGs with their own efforts during their residency, are the limitations of this study.

Conclusion

When general surgeons perform abdominal USG as a supplementary technique, the rate of negative appendectomy is decreased. In conclusion, we believe that incorporation of USG education, at least enough to distinguish the causes of acute abdomen, into general surgery residency education will increase the diagnostic and therapeutic success of the specialists working in the rural areas, and decrease mistakes, and resulting malpractice suits.

Ethics

Ethics Committee Approval: This study was conducted in a retrospective clinical study, ethical committee approval was not required.

Informed Consent: This study was conducted in a retrospective clinical study, patient consent was not required.

Peer-review: Internal peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Concept:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Design:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Data Collection or Processing:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Analysis or Interpretation:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Literature Search:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız, **Writing:** Hüseyin Taş, Şahin Kaymak, Emin Lapsekili, Rahman Şenocak, Ramazan Yıldız.

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References

1. Kamin RA, Nowicki TA, Courtney DS, Powers RD. Pearls and pitfalls in the Emergency department evaluation of abdominal pain. *Emerg Med Clin North Am* 2003;21:61-72.
2. Ma OJ, Mateer JR, Ogata M, Kefer MP, Wittmann D, Aprahamian C. Prospective analysis of a rapid trauma ultrasound examination performed by emergency physicians. *J Trauma* 1995;38:879-885.
3. Shih CH. Effect of emergency physician-performed pelvic sonography on length of stay in the emergency department. *Ann Emerg Med* 1997;29:348-351.
4. Birnbaum BA, Wilson SR. Appendicitis at the millennium. *Radiology* 2000;215:337-348.
5. Binnebösel M, Otto J, Stumpf M, Mahnken AH, Gassler N, Schumpelick V, Truong S. Acute appendicitis. *Modern diagnostics-surgical ultrasound. Chirurg* 2009;80:579-587.
6. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med* 1986;15:557-564.
7. Rioux M. Sonographic detection of the normal and abnormal appendix. *AJR Am J Roentgenol* 1992;158:773-778.
8. Amgwerd M, Röthlin M, Candinas D, Schimmer R, Klotz HP, Largiader F. Ultrasound diagnosis of appendicitis by surgeons--a matter of experience? A prospective study. *Langenbecks Arch Chir* 1994;379:335-340.
9. SCOAP Collaborative, Cuschieri J, Florence M, Flum DR, Jurkovich GJ, Lin P, Steele SR, Symons RG, Thirlby R. Negative appendectomy and imaging accuracy in the Washington State Surgical Care and Outcomes Assessment Program. *Ann Surg* 2008;248:557-563.
10. Gaitini D, Beck-Razi N, Mor-Yosef D, Fischer D, Ben Itzhak O, Krausz MM, Engel A. Diagnosing acute appendicitis in adults: accuracy of color Doppler sonography and MDCT compared with surgery and clinical follow-up. *AJR Am J Roentgenol* 2008;190:1300-1306.
11. Laméris W, van Randen A, van Es HW, van Heesewijk JP, van Ramshorst B, Bouma WH, ten Hove W, van Leeuwen MS, van Keulen EM, Dijkgraaf MG, Bossuyt PM, Boermeester MA, Stoker J; OPTIMA study group. Imaging strategies for detection of urgent conditions in patients with acute Abdominal pain: diagnostic accuracy study. *BMJ* 2009;338:2431.
12. Toorenvliet BR, Wiersma F, Bakker RF, Merkus JW, Breslau PJ, Hamming JF. Routine ultrasound and limited computed tomography for the diagnosis of acute appendicitis. *World J Surg* 2010;34:2278-2285.
13. Butfort JM, Dassinger MS, Smith SD. Surgeon-performed ultrasound as a diagnostic tool in appendicitis. *J Pediatr Surg* 2011;46:1115-1120.
14. Zielke A, Hasse C, Sitter H, Kisker O, Rothmund M. "Surgical" ultrasound in Suspected acute appendicitis. *Surg Endosc* 1997;11:362-365.
15. Sitter H, Hoffmann S, Hassan I, Zielke A. Diagnostic score in appendicitis. Validation of a diagnostic score (Eskelinen score) in patients in whom acute appendicitis is suspected. *Langenbecks Arch Surg* 2004;389:213-218.
16. Saidi HS, Chavda SK. Use of a modified Alvarado score in the diagnosis of acute appendicitis. *East Afr Med J* 2003;80:411-414.
17. Turan AN, Kapan S, Kütükçü E, Yiğitbaş E, Hatipoğlu S, Aygün E. Comparison of Operative and nonoperative management of acute appendicitis. *Ulusal Travma Acil Cerrahi Derg* 2009;15:459-462.
18. Çam R, Kuterdem E, Sayek İ, Baskan S, Tatlıcıoğlu E, Bostanoğlu S, Buğra D, Özmen M, Terzi C, Kılıçturgay S, Cox SS, et al. Türk Cerrahi Yeterlik Yürütme Kurulu. Genel Cerrahi Uzmanlık Eğitimi Çekirdek Eğitim Programı. *Ankara* 2006:126-152.